

### **REMARKS**

In view of the above amendments and the following remarks, reconsideration of the objections and rejections contained in the Office Action of November 3, 2004 is respectfully requested.

The Examiner objected to the abstract due to a minor informality. In view of this objection, and in order to make various additional editorial corrections so as to generally improve the form of the application, the entire specification and abstract have been reviewed and revised. As the revisions are quite extensive, the amendments to the specification and abstract have been incorporated into the attached substitute specification and abstract. For the Examiner's benefit, a marked-up copy of the specification indicating the changes made thereto is also enclosed. No new matter has been added by the revisions. Entry of the substitute specification is thus respectfully requested. In view of the above, it is respectfully submitted that the Examiner's objection to the specification has been overcome.

In view of the Preliminary Amendment filed September 10, 2003, claims 1-12 are presently pending in this application. In this regard, the Examiner has rejected claims 1, 2, 5-7, and 10 as being anticipated by the Kishline reference (USP 2,842,063). However, the Examiner has also indicated that dependent claims 3, 4, 8, 9, 11, and 12 contain allowable subject matter. Therefore, the original claims have now been cancelled and replaced with new claims 13-26, including new independent claim 13, as indicated above. For the reasons discussed below, it is respectfully submitted that the new claims are clearly patentable over the prior art of record.

In item 4 on page 3 of the Office Action, the Examiner indicated that original dependent claim 3 was allowable "due to the limitation of the annular member comprising a flange formed at the circumferential portion so as to face the end face of the engage pin." In view of these reasons for indicating allowable subject matter, new independent claim 13 has now been drafted to incorporate all of the subject matter of original base independent claim 1, as well as the subject matter from original claim 3 quoted above and discussed by the Examiner in item 4 on page 3 of the Office Action. Therefore, in view of the Examiner's indication of allowable subject matter, it is respectfully submitted that independent claim 13 and the claims that depend therefrom are clearly patentable over the prior art of record.

In view of the above amendments and remarks, it is submitted that the present application is now in condition for allowance. However, if the Examiner should have any comments or suggestions to help speed the prosecution of this application, the Examiner is requested to contact the Applicant's undersigned representative.

Respectfully submitted,

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## **BACKGROUND OF THE INVENTION**

### **1. Field of the Invention**

[0001] The present invention relates to a water pump, and particularly relates to a water pump which circulates cooling water of a water-cooled internal combustion engine within the internal combustion engine.

### **2. Description of the Related Art**

[0002] Conventionally, with a water-cooled internal combustion engine 1 shown in Fig. 5 for example, a water pump 2 is disposed to perform cooling of the internal combustion engine 1.

[0003] The water pump 2 is disposed integrally to a crank case 3 of the internal combustion engine 1, and is driven by a crank shaft 4 which is accommodated in the crank case 3. With this structure, cooling water which is cooled by a ~~radiator, not~~ radiator (not shown in figures, the figures) is led to a water jacket 6 in a cylinder block 5 of the internal combustion engine 1 for example, and the cooling is performed.

[0004] As shown in Fig. 6, the water pump 2 comprises a pump body 7, a pump shaft 9 ~~which is~~ rotatably supported by the pump body 7 in a piercing state and to which an impeller 8 is attached at one end portion, and a mechanical seal 10 which is elastically disposed between the side of the pump shaft 9 where the impeller 8 is attached and the pump body 7.

[0005] The mechanical seal 10 is constructed ~~by~~ of a seal member 11 and a spring 12 which elastically urges the seal member 11 towards the impeller 8.

**[0006]** Here, when the mechanical seal 10 is ~~disposed~~ provided, contact pressure between the mechanical seal 10 and the impeller 8 has to be ensured. Further, the dislodging of the pump shaft 9 from the pump body 7 by the urging force of the mechanical seal 10 has to be prevented. For these purposes, a dislodging prevention pin 13 is ~~disposed to~~ arranged at the pump shaft 9 opposite to the side where the impeller 8 is attached, ~~being and~~ in contact with the pump body 7, so as to receive force in the thrust direction generated by the mechanical seal 10.

**[0007]** Further, the pump shaft 9 has a two-point mounting structure ~~that in which~~ a midway portion is rotatably supported by the pump body 7, and an end portion is rotatably supported by the crank case 3 to which the pump body 7 is attached. For example, Fig. 1 of Japanese Utility-model Kokoku H6-31197 discloses this structure.

**[0008]** Furthermore, Fig. 7 shows another structure example of the water pump 2 of the related art. With this water pump 2, a flange 14 is integrally formed at the midway portion of the pump shaft 9 so as to receive the force in the thrust direction generated by the mechanical seal 10 and prevent dislodging of the pump shaft 9. For example, Fig. 1 of Japanese Patent Laid-open 2000-87744 discloses this structure.

**[0009]** Here, since the pump shaft 9 of the abovementioned former water pump 2 is supported by two points which are apart from each other, it has the following problems to be solved.

**[0010]** Specifically, because one of the supporting points of the pump shaft 9 is disposed at the pump body 7, and the other supporting point is disposed at the crank case 3 to which the pump body 7 is attached, the axes of the two supporting points have to be aligned accurately. As a

result, there arises a problem in that high accuracy machining is required and the manufacturing cost is increased.

**[0011]** Further, in addition to the abovementioned machining accuracy of the supporting points, since the assembling accuracy of the pump body 7 with the crank case 3 affects the abovementioned alignment accuracy, there arises a problem in that the assembling process becomes complicated.

**[0012]** Next, with the abovementioned latter water pump2, because the pump shaft 9 is supported at one point, the problems of the former water pump 2 are solved. However, since the flange 14 to prevent dislodging has to be formed integrally with the pump shaft 9, the following problems have to be solved.

**[0013]** Specifically, because the flange 14 is formed integrally with the pump shaft 9, a simple machining method, such as centerless grinding, cannot be adopted when grinding the outer face of the pump shaft 9. As a result, there arises a problem in that the manufacturing cost is increased.

**[0014]** Further, as mentioned above, because the flange 14 is formed integrally with the pump shaft 9, at the time of assembling, the impeller 8 has to be attached to the pump shaft 9 after the pump shaft 9 is inserted to into the pump body 7. Therefore, the impeller 8 cannot be assembled with the pump shaft 9 in advance.

**[0015]** As a result, the assembling process is restricted.

**[0016]** The present invention was devised in ~~the~~—light of the abovementioned problems. The object is to provide a water pump in which machining accuracy and assembling accuracy can be easily improved.

## **SUMMARY OF THE INVENTION**

**[0017]** To achieve the abovementioned object, the water pump ~~of claim 4~~ of the present invention ~~comprises,~~ comprises a pump body, a pump shaft which is rotatably supported by the pump body in a piercing state and to which an impeller is attached at one end portion, a mechanical seal which is disposed elastically via an urging means between the pump body and the end portion of the pump shaft where the impeller is attached, and an engage mechanism which is disposed between the pump body and the end portion of the pump shaft opposite to the side where the impeller is attached, while engaging the pump shaft to the pump body against the urging force of the urging means, ~~wherein the means.~~ The engage mechanism comprises an annular member which is rotatably fitted to the pump shaft while contacting the pump body, and a cylindrical engage pin which pierces the pump shaft in the diameter direction while sandwiching the annular member with the pump body.

**[0018]** With the water pump ~~of claim 2~~ of the present invention, the annular member ~~of claim 1 is~~ may be formed so that the cross section in the diameter direction is roughly circular.

**[0019]** With the water pump ~~of claim 3~~ of the present invention, the annular member ~~of claim 1 is~~ may be formed so that the cross section in the diameter direction is plate-shaped, and an annular flange is formed at the circumference portion so as to face the end face of the engage pin.

**[0020]** With the water pump ~~of claim 4~~ of the present invention, the urging means ~~of claim 3 is~~ may be formed so that the possible expansion-and-contraction stroke is at least equal to the height of the flange.

**[0021]** With the water pump ~~of claim 5~~ of the present invention, the

impeller of ~~any one of claim 1 through 4 is~~ may be attached integrally to the pump shaft.

**[0022]** With the water pump of ~~claim 6 of~~ the present invention, the impeller of ~~claim 5 is~~ may be integrated with the pump shaft by insert molding.

**[0023]** With the water pump of the present invention, the pump shaft is supported at one point so that the alignment to the pump body can be easily performed.

**[0024]** Further, since the part projecting outside in the diameter direction is eliminated from the face of the pump shaft, the grinding of the outer face can be easily performed and ~~the~~ accurate machining can be obtained. As a result, smooth rotation of the pump shaft can be ensured. Further, a simple machining method, such as centerless grinding, can be adopted. This method, as well as the abovementioned easiness of the alignment, enables ~~the~~ reduction of the machining cost.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0025]** Fig. 1 is a longitudinal sectional view showing an embodiment of the present invention.

**[0026]** Fig. 2 shows an annular member for an embodiment of the present invention. Fig. 2 (a) is a longitudinal sectional view, and (b) is a front view.

**[0027]** Fig. 3 is a longitudinal sectional view showing an assembling process of an embodiment of the present invention.

**[0028]** Fig. 4 shows another embodiment of the present invention. Fig. 4 (a) is a longitudinal sectional view, and (b) is a front view.

[0029] Fig. 5 is a schematic side view of an internal combustion engine to which a water pump is adopted.

[0030] Fig. 6 is a longitudinal sectional view showing an example of the related art.

[0031] Fig. 7 is a longitudinal sectional view showing another example of the related art.

### **DESCRIPTION OF THE PREFERRED EMBODIMENT**

[0032] An embodiment of the present invention is explained in the following with reference to Fig. 1 through 3.

[0033] Here, in the following explanation, the same numerical ~~note is~~ numbers are given to the same structure ~~of as~~ the related art to simplify the explanation.

[0034] The water pump shown by numeral 20 in Fig. 1 basically ~~comprises,~~ comprises a pump body 21 which is attached to the crank case 3, a pump shaft 23 which is rotatably supported by the pump body 21 in a piercing state and to which an impeller 22 is attached at one end portion, and a mechanical seal 24 which is disposed elastically via an urging means between the pump body 21 and the end portion of the pump shaft 23 where the impeller 22 is ~~attached, and an attached.~~ An engage mechanism 25 ~~which is~~ disposed between the pump body 21 and the end portion of the pump shaft 23 opposite to the side where the impeller 22 is attached, ~~while engaging and engages~~ the pump shaft 23 to the pump body 21 against the urging force of the urging means, ~~wherein the means~~ The engage mechanism 25 comprises an annular member 26 ~~which is~~ rotatably fitted to the pump shaft 23 while contacting the pump body 21, and a cylindrical



engage pin 27 which pierces the pump shaft 23 in the diameter direction while sandwiching the annular member 26 with the pump body 21.

[0035] Following is more precise explanation. The mechanical seal 24 is constructed ~~by of~~ a seal member 28 which is pressed to contact the side face of a rotating center portion of the impeller 22, and an urging ~~means~~ member 30 having a spring etc. which is disposed between the seal member 28 and a spring seat 29 engaged in the pump body 21 so that the seal member 28 is pressed to contact the impeller 22 elastically.

[0036] As precisely shown in Fig. 2, with this embodiment, the annular member 26 is formed so that the cross section in the diameter direction is plate-shaped, and an annular flange 26a is formed at its circumference portion (i.e., along a circumference of a pate-shaped base portion, as illustrated in Fig 2a) so as to face the end face of the engage pin 27. As a whole, ~~it is formed like the annular member 26 has~~ a bowl-shape, and a penetrating hole 26b to which the pump shaft 23 is inserted is formed around its center.

[0037] Here, the inner diameter of the flange 26a is larger than the length of the engage pin 27, so that the engage pin 27 can be housed in the flange 26a. With this structure, when the engage pin 27 rotates with the pump shaft 23, the flange 26a prevents oil which is stuck to the engage pin 27 from splashing. Therefore, the splashing of the oil to lubricate the engage pin 27 and the annular member 26 can be prevented.

~~With this structure, when the engage pin 27 rotates with the pump shaft 23, the flange 26a prevents oil which is stuck to the engage pin 27 from splashing. Therefore, the splashing of the oil to lubricate the engage pin 27 and the annular member 26 can be prevented.~~

[0038] As shown in Fig. 1, a piercing hole 23a is formed at in the pump shaft 23 in the diameter direction to which the engage pin 27 is fitted.

[0039] Further, the urging ~~means~~ member 30 is constructed so that the amount of the expansion-and-contraction stroke is equal to or larger than the height H of the flange 26a. When the urging ~~means~~ member 30 is contracted, the piercing hole 23a ~~which is formed at in~~ the pump shaft 23 ~~positions is positioned~~ outside the flange 26a of the annular member 26 which ~~is in the state of being contacted with~~ contacts the pump body 21.

[0040] Meanwhile, ~~as shown in Fig. 1, with in~~ this embodiment, the impeller 22 is formed of synthetic resin, and is attached integrally to ~~the one~~ a first end portion of the pump shaft 23 by insert ~~molding~~ molding, as shown in Fig. 1.

[0041] Following is ~~the an~~ explanation of the assembling process of the water pump 20 of this embodiment, which is constructed as mentioned above.

[0042] First, the seal member 28 of the mechanical seal 24 is attached to the impeller 22. Then, the urging ~~means~~ member 30 of the mechanical seal 24 is attached to ~~one~~ a first end portion of the inserted part of the pump body 21 ~~to into~~ which the pump shaft 23 is inserted. Then, the pump shaft 23 with the impeller 22 and the seal member 28 attached is inserted through the urging ~~means~~ member 30 of the mechanical seal 24, from the second end portion where the impeller 22 is not attached. Then, the second end portion of pump shaft 23 protrudes from the opposite side of the pump body 21, and the annular member 26 is fitted to the second end portion, as shown by the arrow X in Fig. 3.

[0043] Next, the pump shaft 23 is further pressed into the pump body

21, so that the urging ~~means-member 30 constructing of~~ the mechanical seal 24 is fully contracted, while the annular member 26 is contacted to the pump body 21.

**[0044]** In this state, the piercing hole 23a formed at the pump shaft 23 ~~positions-is positioned~~ at the outer side of the flange 26a of the annular member 26.

**[0045]** Then, as shown by the arrow Y in Fig. 3, the engage pin 27 is fitted in the piercing hole 23a of the pump shaft 23. After adjusting the engage pin 27 to a position inside the flange 26a of the annular member 26, the pressing force applied to the pump shaft 23 is released.

**[0046]** With the abovementioned process, the pump shaft 23 and the impeller 22 are moved by the urging ~~means-member 30 constructing of the~~ mechanical seal 24, in the direction where the impeller 22 is apart from the pump body 21. Then, the engage pin 27 contacts the annular member 26 while being housed in the flange 26a of the annular member 26. In this manner, the pump shaft 23 and impeller 22 are attached to the pump body 21, as shown in Fig. 1.

~~In this manner, the pump shaft 23 and impeller 22 are attached to the pump body 21, as shown in Fig. 1.~~

**[0047]** With the water pump 20 of this embodiment assembled as mentioned above, the pump shaft 23 is supported at one point. Therefore, the alignment is easily performed.

**[0048]** Further, the pump shaft 23 has no part projecting outside in the whole range in the diameter direction. Therefore, the grinding of the outer face is easily performed, and accurate machining can be obtained. As a result, smooth rotation of the pump shaft 23 can be ensured. Further, since

the pump shaft 23 has no part projecting outside in the diameter direction, a simple machining method, such as centerless grinding, can be adopted to reduce the manufacturing cost.

~~As a result, smooth rotation of the pump shaft 23 can be ensured.~~

**[0049]** Further, since the pump shaft 23 has no part projecting outside in the diameter direction, a simple machining method, such as centerless grinding, can be adopted to reduce the manufacturing cost.

**[0050]** Furthermore, since the pump shaft 23 can be attached to the pump body 21 only by being inserted from one direction in the axis direction, it is possible to be assembled in the a state that in which the impeller 22 is attached to the pump shaft 23 at the opposite side of the end portion which is inserted to the pump body 21. Therefore, the impeller 22 can be assembled with the pump shaft 23 in advance, and the assembling performance of the water pump 20 is improved as a whole.

~~Therefore, the impeller 22 can be assembled with the pump shaft 23 in advance, and the assembling performance of the water pump 20 is improved as a whole.~~

**[0051]** Furthermore, with this embodiment, since the flange 26a formed at the annular member 26 covers the end portion of the engage pin 27 which contacts the annular member 26, it is possible to prevent the splashing of the oil sticking at the contacting section of the engage pin 27 and the annular member 26. Therefore, smooth sliding between the engage pin 27 and the annular member 26 can be ensured.

**[0052]** The shapes and dimensions etc. of each constructing member of the abovementioned embodiment are just examples, and can be modified variously in accordance with design ~~requirement~~ requirements, etc.

**[0053]** For example, the annular member 26 is not limited to an integrally formed bowl-shaped washer. The same effects can be obtained even when the plate portion which contacts the engage pin 27 and the flange 26a which covers the end portion of the engage pin 27 are formed separately.

**[0054]** Further, as shown in Fig. 4, the annular member 31 to contact the engage pin 27 can be formed so that the cross section in the diameter direction is roughly arc-shaped.

**[0055]** With this structure, since the contact between the annular member 31 and the engage pin 27 is almost point-contact, the sliding resistance, namely the rotating resistance of the pump shaft 23, can be reduced. Therefore, smooth rotation of the pump shaft 23 can be ensured.

**[0056]** Furthermore, the flange 31a can be formed at the circumference of the annular member 31.

### **ABSTRACT OF THE DISCLOSURE**

~~The object is to provide a water pump which machining accuracy and assembling accuracy can be easily improved.~~

~~The~~ A water pump ~~comprises~~ includes an engage mechanism 25 which is disposed between a pump body 21 and the end portion of a pump shaft 23 opposite to the side where an impeller 22 is attached, while engaging the pump shaft to the pump body against the urging force of ~~the~~ an urging means member which urges a mechanical seal 24, ~~wherein the~~ 24. The engage mechanism ~~comprises~~ includes an annular member 26 which is rotatably fitted to the pump shaft 23 while contacting the pump body 21, and a cylindrical engage pin 27 which pierces the pump shaft 23 in the diameter direction while sandwiching the annular member 26 with the pump body 21.